

Letters to the Editor: Comment and Reply

Life Cycle Impact Assessment: The Use of Subjective Judgements in Classification and Characterization by J.W. Owens, *Int. J. LCA* 3 (1) 43-46 (1998)

Comment

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I read the article by J.W. OWENS entitled "Subjective Judgement" in Vol. 3, No. 1 edition of the *J. of LCA*. As usual, Dr. OWENS writes an interesting article, but I am left confused by the very restrictive statements related to human and ecological toxicological impacts. The statements related to subjectivity occasionally appear to be more demanding than in detailed risk assessments (also a very subjective decision making tool). Sometimes the normal level of subjectivity in risk assessment is not considered to be acceptable in the LCA arena. Is there a justification for these higher demands that cannot often be achieved? For a tool that has no legal implications, the level of subjectivity in LCA appears to receive more attention than may be necessary.

In the context of toxicological impacts, the author comments that this "... is not plausible beyond local aggregation." However, this aggregation is performed in risk assessments to determine the potential contribution of an emission and to cause an effect in a specified region. As in LCA, note that no actual effect is calculated (for a number of reasons summarized below). Furthermore, contrary to the authors statement, it appears that the loss of temporal information in the LCA inventory data limits the ability to perform risk assessment on a local scale to a greater extent than on a regional or global basis.

In the case of regional impacts, a release can be thought of in terms of its potential contribution to an effect. Hence, the contribution does not need to be a complete and single emission source. In the case of LCA, the contribution can be related to the fraction of a number of releases associated with a specified functional unit. Naturally, the releases have to occur during similar time periods, for example over the course of one year.

The occurrence of an actual effect in a region will depend on the temporal characteristics of the emissions, the extent of other releases in the region and the quantity of addi-

tional chemicals entering the region through advection. All chemicals released and entering by advection that have analogous toxicological effects have to be considered, unless there is evidence to suggest that the effects are not additive although similar. Hence, the prediction of actual impacts using LCA inventories, or any other emission data, is typically not possible and their contributions can only be estimated.

The potential contribution of a chemical to an effect in a region can be calculated using classical risk assessment paradigms. In the report by GUINEE et al. "LCA Impact Assessment of Toxic Releases", this was demonstrated using a deterministic approach in 1996. (Obviously the quality of data and hence the predictions can vary considerably.) The contribution potentials can be estimated and used to weight the inventory data. No actual impacts can be implied, but the potential contribution to the regional cocktail is estimated on a relative basis using a minimum of scientific judgement as currently possible.

Similarly, the statement by Dr. OWENS that "the ratio of toxicity scores for different chemicals and systems is not likely to be proportional to their relative environmental loadings ..." requires clarification. It is not clear if the author is talking about the inability of LCA inventory data to reflect relative impacts alone or that the toxicity score of a particular chemical is not proportional to its potential contribution to an impact? If the latter statement is valid, then this is debatable since the relative contribution of a specific chemical is approximately linearly proportional to the release magnitude, at least on a regional basis. Hence, contrary to the author's suggestion, regional potentials derived using common risk assessment approaches can be applicable for use in LCA.

One outstanding question is how to combine the resultant weighted inventory data for different chemical emissions.

If the effect endpoints are similar, it is then typical to add the results. However, to provide a "worst" case assessment for a given region, one may just add all the values (although this may not be the worst case if the synergistic effects are considerable.) This summation is subjective and a value greater than one still does not indicate an actual impact. The value provides a relative indicator based on the sum of all the potential contributions associated with different effect endpoints. This is common practice in other impact/risk assessment arenas and no distinction is made between effects. A notable exception is between carcinogens and non-carcinogens, although there are indications that this practice may change.

Similarly, although more detail is gained by considering potential contributions on a regional scale, the decision maker will probably sum the values for the different regions to facilitate a comparison of the different life cycles. Again, this may not indicate actual effects, but it will provide an indication of the overall contributions of one life cycle to facilitate a comparison with another in the category of toxicological impacts. Furthermore, the lack of distinction between areas will avoid discrimination against processes in less pristine regions of the world, a feature that may have both good and bad connotations.

The alternative to simple aggregation may be to consider background concentrations of all the chemicals in each region with a similar effect endpoint, as well as the temporal data for each emission, etc. Unfortunately, this data is not typically available, even for most "detailed" risk assessments. Thus, the decision will typically have to be made on the basis of aggregated data across different effect endpoints and regions unless the application of LCA is to be restricted. As this is the current "state-of-the-art" in many risk/impact assessment domains, not just in LCA, it is hard to see why this practice should be limited on this basis. However, there is obviously room for improvement in the LCA approach and the methodologies used to develop potentials. These advancements may include the inclusion of temporal information to enable the consideration of contributions occurring over different time spans.

References

- [1] GUINEE J., HEIJUNGS R., VAN OERS L., VAN DER MEENT D., VERMEIRE T., RIKKEN M.: LCA Impact Assessment of Toxic Releases, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, May 1996

Reply

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The article referred to by DAVID W. PENNINGTON was a commentary, summarizing the continued evolution of Life Cycle Impact Assessment (LCIA) in one particular area, the use of subjectivity. The commentary pointed to the efforts of SETAC (BARNTHOUSE et al., 1997; UDO DE HAES et al., 1996), ISO (ISO, 1998), and ILSI (ILSI, 1996) to examine and reappraise the use of subjectivity in LCIA. In ISO terminology, subjectivity is referred to as value-choices.

To summarize the trust of the original commentary, the issue is not one of simplifying assumptions that are consistent with basic environmental science. All techniques simplify their models and processes by making assumptions, and all techniques must make these assumptions transparent. The issue for LCIA is the use of subjectivity or scoring schemes. This is especially important to recognize where these scoring schemes are applied and may masquerade as science or fact in LCIA methods.

This important reappraisal by members of the above organizations has consistently supported a key position from the original SETAC Sandestin workshop. A common mode of action or homogeneous mechanism is a necessary and essential element for scientific validity (SETAC, 1993). All of the above organizations, as well as many individuals, have recognized that this common mode of action or homogeneous environmental mechanism does not exist for a number of LCIA impact categories. Instead, scoring schemes are created for a number of impact categories through subjective judgement. These scoring schemes are involved in several ways as noted by the article. Scoring based on subjectivity is the basis for

1. certain impact categories such as resources, ecotoxicity, and human toxicity where independent mechanisms and substances are combined,